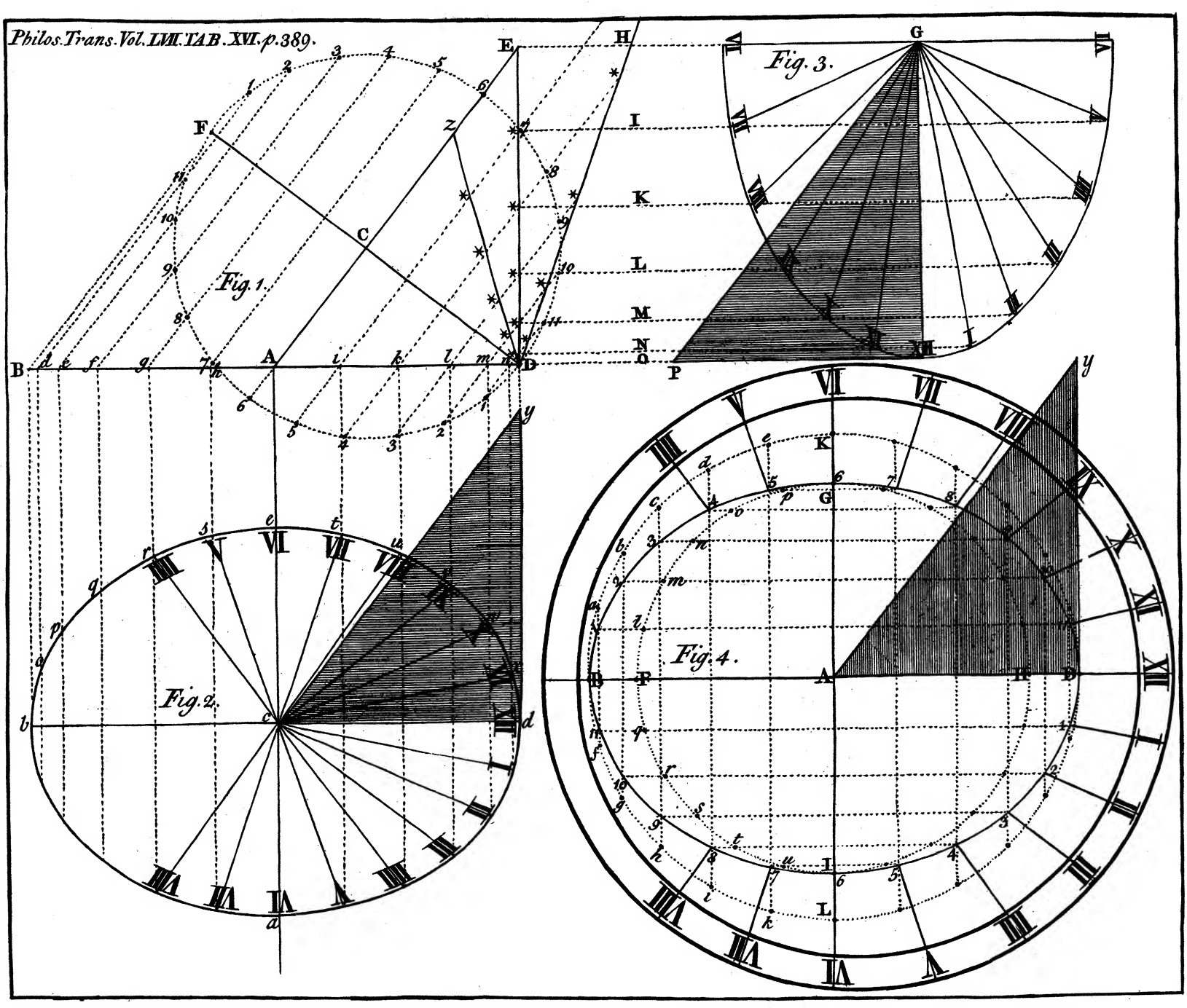
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.

XXXVI. *A new Method of conſtructing Sun-Dials, for any given Latitude, without the Aſſiſtance of Dialing Scales or Logarithmic Calculations.* *By* James Ferguſon, *F. R. S.*

Read July 2, 1767. DRAW the ſtraight horizontal line BAD TAB. XVI. (fig. 1.) of any convenient length, and on the end D thereof raiſe the perpendicular DE.

Biſect BAD at A, and draw the right line ACE, making the angle EAD equal to the latitude of the place for which the dial is to ſerve, as ſuppoſe $51° \frac{1}{2}$ for the latitude of London. Draw alſo the right line FCD, making an angle at D with the horizontal line BAD equal to the co-latitude of the place, or height of the equinoctial. So, FCD will be perpendicular to ACE, BAD will be a horizontal plane ſeen edgewiſe, DE a vertical plane, FCD the plane of the equinoctial, and ACE the axis or ſtile of the dial; the whole triangle ADE repreſenting the whole broad plate or ſtile.

Around the interſection C, as a center, with the radius CD, deſcribe the circle F6D6F, and divide its circumference into 24 equal parts, beginning at D or at F. Then connect all the points of diviſion, which are equidiſtant from F, by the ſtraight lines 1 11, 2 10, 3 9, 4 8, *&c.* continuing as many of

theſe lines as are needful to the horizontal line BAD, and to the vertical line DE.

Continue ED down to *d*, (fig. 2.) and draw *bd* parallel and equal to BD. Draw alſo the right line *Aeca*, from fig. 1. to fig. 2, and that the line will be perpendicular to the line *bd* in fig. 2. cutting it in the middle point *c*.

From fig. 1. take CF or CD in your compaſſes; and in fig. 2. ſet that diſtance from *c* to *e* upwards, and from *c* to *a* downwards, on the right line *Aeca*. So *eca* in fig. 2. ſhall be equal to FCD in fig. 1. and *bcd* in fig. 2. ſhall be equal to BAD in fig. 1.

On theſe two lines *bcd* and *eca* make the ellipſis *bopqr*, &c. according to the common rule for deſcribing an ellipſis upon the tranſverſe and conjugate diameters *bcd* and *eca*. Then, from thoſe points in the horizontal line BAD (fig. 1.) where the right lines 1 11, 2 10, 3 9, &c. meet it, as at *d*, *e*, *f*, *g*, *h*, *A*, *i*, *k*, *l*, *m*, *n*, draw the right lines *do*, *ep*, *fq*, *gr*, &c. quite through the ellipſis, and all parallel to the right line *Aeca*. Then, from the middle point *c* of the ellipſis, draw right lines to thoſe points of its circumference where the foreſaid parallel lines cut it; and they ſhall be the true hour-lines for a horizontal dial; to which ſet the hours, as in fig. 2. Laſtly, in fig. 2. draw *cy* parallel to ACE in fig. 1. and *cy* ſhall be the axis or edge of the ſtile *cdy* that caſts the ſhadow on the time of the day.

The horary ſpaces, or angular diſtances of the hours on the dial, being thus found, there is no occaſion for confining the hours thereon, or the lengths of the hour-lines, within the ellipſis; for they may be

produced beyond it to any diſtance, and the hour-letters placed in a circle, as in fig. 4.

A geometrical method for deſcribing the whole or half an ellipſis will be ſhewn further on.

From fig. 1. contiue out the horizontal line BAD to any length, as to XII in fig. 3. Then, from the points *** in the perpendicular DE (fig. 1.) where the parallel lines 5 7, 4 8, 3 9, 2 10, and 1 11 meet it, draw the right lines H, I, K, L, M, N, all parallel to the horizontal line BA DP XII. producing them at pleaſure: and, in fig. 3. draw G XII parallel to DE in fig. 1. This done, take CF or CD (fig. 1.) in your compaſſes, and ſet off its length both ways from G (fig. 3.) to VI and VI, on the right line *EH* VI *G* VI. So VI *G* VI in fig. 3. ſhall be equal to FCD in fig. 1. and XII *G* in fig. 3. ſhall be equal to DE in fig. 1.

On VI *G* VI as a conjugate diameter, and *G* XII as a ſemi-tranſverſe diameter, deſcribe the ſemi-ellipſe VI, VII, VIII, IX, *&c.* and, to thoſe points of it where the parallel lines H, I, K, L, M, and N cut it, draw the right lines *G* VI, *G* VII, *G* VIII, *G* IX, *&c.* as in the figure; and they will be the true hour-lines for an erect direct ſouth dial: and they may be produced beyond the ellipſis, and limited either by circular or ſquare lines, between which the hours may be placed.

Laſtly, draw PG in fig. 3. parallel to ACE in fig. 1. and PG will be the axis or edge of the ſtile *P* XII *G* for caſting a ſhadow on the time of the day.

And thus, by means of fig. 1. conſtructed for any given latitude, either a horizontal or vertical dial may be made for that latitude.

If

If you want a ſouth dial to incline by any number of degrees, as ſuppoſe 16, draw the line D*z*, making an angle of 16 degrees with the perpendicular DE, in fig. 1. Then D*z* ſhall be the ſemi-tranſverſe axis of the ellipſe, and C6 the ſemi-conjugate: and right lines drawn parallel to DP XII quite through the ſemi-ellipſis, from the points *** in D*z*, where it is cut by the parallel lines 5 7, 4 8, 3 9, *&c.* ſhall cut the ſemi-ellipſis in thoſe points through which the hour-lines muſt be drawn, as from G in the upright ſouth dial, fig. 3.

If you want to make a reclining ſouth dial, draw the line DH (fig. 1.) making an angle with the perpendicular DE equal to the intended angle of reclination, and produce DH and CE till they meet. From D to that meeting, will be the length of the ſemi-tranſverſe axis of the ellipſe, and from C to 6 the length of the ſemi-conjugate: which being found, proceed in all reſpects as above for the ſouth upright dial.

To draw the ellipſis, and find the hour-points in it, obſerve the following method.

For a horizontal dial, as fig. 4. Make the radius AK of the circle BKDL equal to AD in fig. 1. and croſs the circle at right angles by the two diameters BAD and KAL, and divide the circle into 24 equal parts, beginning at B. Connect theſe points of diviſion, which are equidiſtant from B, by the right lines *af*, *bg*, *ch*, &c. all parallel to KAL, as in the figure.

Make the radius AG of the circle FGHI in fig. 4. equal to CF in fig. 1. and divide FGHI into 24 equal parts, beginning at I. Then through theſe points

points of diviſion, which are equidiſtant from I, draw the right lines 7 5, 8 4, 9 3, 10 2, *&c.* till they meet the former right lines, *ek*, *di*, *ch*, *&c.* in the points 7 5, 8 4, 9 3, 10 2, and 11 1, on both ſides of the diameter BAD; all which points are in the elliptical curve, and it is to be drawn through them, by hand, as in the figure.

And right lines drawn from the center A through theſe points in the ellipſis, will be the true hour lines for a horizontal dial.

To draw the ellipſis for a vertical ſouth dial, make DE (in fig. 1.) the radius of the largeſt circle, and CF the radius of the ſmalleſt: the diameter of the former gives the tranſverſe diameter of the ellipſis, and that of the latter gives the conjugate: which being found, conſtruct the ellipſis the ſame way for the vertical dial as above ſhewn for the horizontal; then draw the hour-lines in the ſame manner, from the center of the dial, through thoſe points of the ellipſis where the interſections of the croſs-lines meet it, as in the horizontal; and the thing will be done.